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[Title of the Invention] CERAMIC HEATER

[Abstract]

[Object]

To provide a ceramic heater which has an improved heating capability and is capable of adjusting the plasma generating position in the vicinity of a wafer W.

[Constitution]

In a ceramic heater 1 comprising a resistance heating element 3 which is made of a high melting point metal and is embedded in the inside of a dense ceramic substrate 2, an electrode 6 for plasma generation is embedded in the above-mentioned ceramic substrate 2 and the above-mentioned electrode 6 for plasma generation has a property of insulating the wafer W installation face.

[Claims]

1. A ceramic heater comprising a resistance heating element which is made of a high melting point metal and is embedded in the inside of a dense ceramic substrate, wherein

an electrode for plasma generation is embedded in said ceramic substrate, and

said electrode for plasma generation has a property of insulating the wafer installation face.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a ceramic heater comprising a resistance heating element which is made of a high melting point metal and is embedded in the inside of a dense ceramic substrate, and more particularly to a ceramic heater advantageously usable for a wafer heating device for a semiconductor producing device.

[0002]

[Prior Art]

In a semiconductor producing device requiring super clean condition, a corrosive gas such as chloride type gas or fluoride type gas is used as a gas for deposition, a gas for etching, a gas for cleaning and the like. For that, if a conventional heater comprising a resistance heating element coated with a metal such as a stainless steel or Inconel in the surface is used as a heating device for heating a wafer in the state that the wafer is brought into contact with such a corrosive gas, undesirable particles of chlorides, oxides, fluorides and the like with a particle diameter of several μm are formed owing to exposure to the gas.

[0003]

Therefore, for example, in an etching or CVD device to be used at a low temperature, as one example of the device shown in Fig. 3, an indirect heating constitution has been employed in which an IR lamp 23 is installed in the outside of a container 21, which is to be exposed to a gas for deposition, with the interposition of a quartz window 22; a susceptor 25 made of, for example, aluminum is installed in the container 21 via an arm 24; and the susceptor 25 is heated by the IR lamp 23 to indirectly heat a wafer W put on the susceptor 25. The susceptor 25 made of metal is used

as an electrode for plasma generation and high frequency is directly applied to the susceptor 25 to generate plasma and carry out cleaning. In this case, if the susceptor 25 is made of aluminum, an insulating layer is formed by alumite treatment of the surface to prevent direct application of electric current to the wafer W mounted thereon.

[0004]

[Problems to be Solved by the Invention]

However, in the above-mentioned conventional example, since the susceptor 25 is made of metal, there is a problem that heavy metal contamination with metals in a high temperature process takes place. Especially, in the case of the susceptor 25 made of aluminum, contamination with Mg is a problem. In order to solve such a contamination problem, as one example shown in Fig. 4, those with a structure in which a susceptor 25 is made of an insulating ceramic and a plate-like electrode 26 for plasma generation is attached to the back face have been proposed. However, since the plate-like electrode 26 for high frequency supply shuts the IR from an IR lamp 23, there occurs a problem that heating capability of the susceptor 25 is deteriorated. Further, since the position of plasma generation is more parted from a wafer W, there occurs another problem that the cleaning property is deteriorated. A similar problem is caused also in the case a ring-like electrode is installed in the outer circumference of a susceptor.

[0005]

On the other hand, as a method for heating without using the IR lamp 23, it may be possible to use a ceramic heater comprising a resistance heating element embedded in the susceptor 25 made of ceramic, however,

similar to the example shown in Fig. 4, a plate-like electrode 6 for plasma generation has to be attached to the back face, so that a problem similar to the problem occurring in the case of the example shown in Fig. 4 is also caused.

[0006]

An object of the present invention is to solve the above-mentioned problems and to provide a ceramic heater which has an improved heating capability and is capable of adjusting the plasma generating position in the vicinity of a wafer W.

[0007]

[Means for Solving the Problems]

A ceramic heater of the present invention is a ceramic heater comprising a resistance heating element which is made of a high melting point metal and is embedded in the inside of a dense ceramic substrate, wherein an electrode for plasma generation is embedded in the ceramic substrate, and the electrode for plasma generation has a property of insulating the wafer installation face.

[0008]

[Operation]

In the above-mentioned constitution, since the heater part is made to have a structure where a resistance heating element made of a high melting point metal is embedded in a dense ceramic substrate, a wafer can be directly heated while being mounted on the heater part and the uniform heating property and the response at the time of heating can be improved. Further, since the electrode for plasma generation is embedded in the

ceramic substrate, the wafer can be directly mounted on the ceramic heater without a risk of contamination and therefore no means for forming an insulating layer or the like is required and the position of the plasma generation is in the vicinity of the wafer, so that plasma generation situation and the cleaning capability by plasma can be improved.

[0009]

[Examples]

Fig. 1 illustrates the structure of a ceramic heater 1 of the present invention. In the example shown in Fig. 1, a resistance heating element 3 made of a high melting point metal such as W or Mo is embedded in the inside of, for example, a disk-like ceramic substrate 2. It is preferable that the resistance heating element 3 is wound spirally and installed so as to form a coil-like shape by plan view observation of the disk-like ceramic substrate 2. Both end parts of the resistance heating element 3 are connected to terminals 4 for electric power supply and successively a cable 5 connected to the terminals for electric power supply. Further, a disk-like electrode 6 for plasma generation with a diameter slightly smaller than that of the ceramic substrate 2 is installed in the upper side of the resistance heating element 3 in the inside of the ceramic substrate 2, and the electrode 6 for plasma generation is connected to terminals 7 for high frequency supply and successively cables 8 in a proper number corresponding to the high frequency signals to be supplied (in this case only one cable).

[0010]

Since the ceramic substrate 2 is heated at highest from 600°C to 1100°C in the case of, for example, a thermal CVD device, in terms of heat

resistance, it is preferable that the ceramic substrate 2 is made of alumina, a silicon nitride sintered body, sialon, silicon carbide, aluminum nitride, an alumina-silicon carbide composite material and the like. Especially, it is preferable that the ceramic substrate 2 is made of non-oxide type ceramics. That is because, as compared with oxide ceramic such as alumina, the non-oxide covalent ceramics such as SiC, Si₃N₄, and AlN emit a less amount of gas under high vacuum. Among them, it is especially preferable to use silicon nitride, because the overall strength of the ceramic heater 1 is increased and its thermal expansion coefficient is approximately the same as that of silicon, a typical material for a wafer, and the durability in a corrosive gas is also high.

[0011]

The ceramic substrate 2 is composed of a film-like substrate 2a and a plate-like substrate 2b to embed a plasma electrode and can be produced from not only a single material but also different materials. It is preferable that the film-like substrate 2a has a volume resistance of $10^8 \Omega\text{cm}$ or more and a film thickness of 10 μm or more in order to avoid the effect on a semiconductor device by electric current flow to a wafer. Further, the film-like substrate 2a is disposed in a plasma sheath and receives impact by ion bombardment of molecules activated by bias application to the electrode 6. For that, the film-like substrate 2a is required to have durability under the ion bombardment and therefore it is preferable that its thickness is 100 μm or more. However, if the thickness of the film-like substrate 2a increases, the high frequency power loss is increased owing to the dielectric loss by high frequency application and therefore it is preferable that the

thickness is 1 mm or less. Further, the film-like substrate 2a and the plate-like substrate 2b may be joined by an insulating bonding material such as borosilicate glass or oxynitride glass other than by integration forming. The electrode 6 is required to contain a reactance component decreased enough to sufficiently transmit high frequency and is required to have a sufficient thickness so as to lower the resistance to 1 Ω or less. Therefore, in the case the electrode 6 is produced from tungsten or molybdenum, the thickness is required to be 8 μm or more.

[0012]

Fig. 2 illustrates constitution of one example of a heating device in which a ceramic heater 1 of the present invention is installed. In the example shown in Fig. 2, the ceramic heater 1 is installed via an arm 12 in a container 11 which is to be exposed to a gas for deposition. In this case, the ceramic heater 1 is installed in such a manner that the electrode 6 for plasma generation is set in the top face side, and a wafer W is mounted on the top face of the ceramic heater 1. Further, a pair of cables 5 for electric power supply and the cable 8 for high frequency signal supply are arranged so that each forms electric communication with outer parts of the container 11. In such a condition, electric power for heating the resistance heating element 3 is supplied through a pair of the cables 5 and a high frequency signal is supplied through the cable 8 to generate plasma and accordingly heating and plasma generation can be performed.

[0013]

The present invention is not limited to the above-mentioned Examples and a variety of modifications and alterations are possible. For

example, in the above-mentioned Examples, the electrode 6 is used only as an electrode for plasma generation, but it may work simultaneously as an electrostatic chuck electrode for chucking a wafer W by electrostatic capacity. For example, in the case a DC voltage is applied to generate electrostatic capacity in the electrode 6 and at the same time a high frequency signal is supplied through an insulating transformer, the wafer W can be attracted to the top face of the ceramic heater 1 and simultaneously plasma can be generated. Incidentally, at the time of supplying the high frequency signal, four cables each with a resistance value of 1 Ω or less and, in the case of tungsten, with a diameter of at least 10 mm are required. This is significantly different from the case the electrode is used only as an electrostatic chuck electrode, wherein a resistance value of 0 to several hundred Ω and a diameter of about 0.1 mm are adequate.

[0014]

[Effect of the Invention]

As being made clear from the above-mentioned descriptions, according to the present invention, a ceramic heater has a structure of a heater part composed by embedding a resistance heating element made of a high melting point metal in a dense ceramic substrate, so that the heater can directly heat a wafer with the wafer being mounted thereon and is provided with improved uniform heating property and response at the time of heating. At the same time, since an electrode for plasma generation is embedded in the ceramic substrate, the wafer can be mounted directly on the ceramic heater with no risk of contamination and no means for installing an insulating layer is required. Furthermore, the position of

plasma generation is in the vicinity of the wafer, so that the plasma generation situation and cleaning capability by plasma can also be improved.

[Brief Descriptions of the Drawings]

[Fig. 1]

Fig. 1 illustrates the structure of one example of a ceramic heater of the present invention.

[Fig. 2]

Fig. 2 illustrates the structure of one example of a heating device in which a ceramic heater of the present invention is incorporated.

[Fig. 3]

Fig. 3 illustrates the structure of one example of a conventional heating device.

[Fig. 4]

Fig. 4 illustrates the structure of another example of a conventional heating device.

[Descriptions of Reference Numerals]

- 1 ceramic heater
- 2 ceramic substrate
- 3 resistance heating element
- 4, 7 terminal
- 5, 8 cable
- 6 electrode for plasma generation